A Neural Network Approach to Predict Stock Prices of ESG Companies Using Technical Indicators

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http://doi.org/10.64643/JATIRV1I1-140038-001

Abstract: **This paper explores the application of neural networks, specifically the Multilayer Perceptron (MLP), for short-term stock price prediction of companies aligned with Environmental, Social, and Governance (ESG) principles. The study analyzes data from 100 ESG-compliant firms across 16 sectors, covering June 2024 to June 2025. Technical indicators such as MACD, EMA, Signal Line, and Volume were employed as input variables. Data preparation was conducted using Microsoft Excel, while model training and validation were performed in IBM SPSS. The findings reveal that the MLP model achieved high accuracy, with most prediction errors within ±1 of actual stock prices. Variable importance analysis highlighted the closing price and momentum indicators as dominant factors influencing predictions. Scatter plot validation confirmed a strong correlation between predicted and actual values. This research demonstrates that combining ESG-focused company selection with AI-driven modeling provides reliable tools for sustainable investing. Future improvements may include integrating ESG scores, sentiment analysis, and macroeconomic indicators.**

***Index Terms*— Neural Network, ESG Companies, Stock Price Prediction, Technical Indicators, Machine Learning, Sustainable Investing.**

I. INTRODUCTION

Stock price prediction has long been one of the most complex and debated challenges in the field of finance. Prices are influenced by multiple factors including market volatility, investor sentiment, company performance, policy changes, and global events. Traditional statistical and econometric models often fail to capture the non-linear, dynamic, and time-dependent nature of stock market movements, resulting in limited predictive power. With the rise of big data and computational advances, artificial intelligence (AI) methods such as neural networks have gained prominence in financial forecasting due to their ability to recognize hidden patterns and model complex relationships. In recent years, investors and researchers have also turned their attention to companies that comply with Environmental, Social, and Governance (ESG) standards. ESG-compliant firms are considered more transparent, ethical, and sustainable, making them attractive to long-term investors. Unlike speculative or high-risk companies, ESG firms demonstrate stronger governance and responsible practices, which may also contribute to more stable financial performance. This stability provides a strong foundation for developing reliable forecasting models. This study focuses on predicting short-term stock prices of 100 ESG-compliant companies across 16 sectors in India. Although ESG scores themselves were not used as direct input variables, the company selection process was based on recognized ESG practices to ensure the dataset represented responsible and sustainable firms. The forecasting model integrates traditional technical indicators, such as Moving Average Convergence Divergence (MACD), Exponential Moving Averages (EMA), Signal Line, and Volume, with a Multilayer Perceptron (MLP) neural network. By combining ESG-based company selection, technical analysis, and neural network modeling, this research aims to improve short-term stock forecasting accuracy. Beyond its technical contribution, the study also addresses the growing importance of sustainable investing by demonstrating how AI tools can support responsible investment decisions. The findings are expected to provide practical insights for traders, analysts, and institutional investors who wish to balance profitability with sustainability in their portfolio strategies.

II. LITERATURE REVIEW

The growing intersection of artificial intelligence (AI), stock market prediction, and sustainable investing has attracted increasing academic attention in recent years. Several studies have explored the predictive power of machine learning models as well as the financial implications of Environmental, Social, and Governance (ESG) practices, offering insights into the evolving landscape of sustainable finance. Ghallabi et al. (2025) investigated the application of advanced machine learning methods—specifically Random Forest, XGBoost, and CatBoost—for forecasting ESG stock market performance and clean energy price trends. Their findings highlighted the superiority of ensemble models in capturing complex financial dynamics and improving predictive accuracy. Based on a large dataset spanning nearly a decade (2014–2023), the study demonstrated that AI-based models can contribute significantly to decision-making in sustainable investing by

incorporating ESG–energy linkages into financial forecasting. In a related dimension, Barontini and Gioja (2025) focused on the role of ESG index providers and their influence on capital markets. Using regression analysis and cumulative abnormal returns (CAR) across data from 2011 to 2021, the study revealed that ESG indices exert considerable market power during rebalancing periods, leading to notable capital shifts. These findings raised concerns about the transparency and neutrality of ESG indices, suggesting that such benchmarks may amplify or distort market signals rather than simply reflecting sustainable performance. This perspective underscores the importance of critically assessing the construction of ESG indices when using them as investment tools. At the firm level, Shrestha et al. (2025) examined the relationship between ESG ratings and financial performance in emerging markets. Drawing on data from 2016 to 2019, the study confirmed a strong positive correlation, with robustness tests validating the stability of the results. The research concluded that companies with higher ESG ratings were more likely to attract capital, reinforcing the notion that sustainable practices provide not only ethical benefits but also tangible financial advantages. This is particularly relevant in developing markets, where investor confidence is often influenced by governance and transparency factors. The resilience of ESG investments in times of crisis was further emphasized by Dai (2020), who analyzed the impact of the COVID-19 pandemic on ESG portfolios between 2020 and 2022. Using the spanning test, the study demonstrated that ESG-aligned portfolios acted as an "equity vaccine," offering diversification benefits and cushioning against severe market shocks. These results support the idea that ESG considerations are not merely ethical preferences but also practical strategies for risk mitigation and portfolio stability, particularly during periods of heightened uncertainty. Finally, Chhajer et al. (2021) highlighted the contribution of AI techniques to financial forecasting by comparing Artificial Neural Networks (ANN), Support Vector Machines (SVM), and Long Short-Term Memory (LSTM) networks. Using financial data from 2020 to 2021, the study showed that deep learning approaches achieved high predictive accuracy, especially under volatile market conditions. The findings underscored the effectiveness of AI in recognizing non-linear patterns and improving forecasting reliability. Importantly, the study also suggested that integrating AI-driven models with ESG investing frameworks could enhance the quality of decision-making for investors seeking both profitability and sustainability. Taken together, these studies reveal three central themes: the effectiveness of AI and machine learning in financial prediction, the growing significance of ESG in shaping investment decisions, and the resilience of ESG-aligned portfolios in times of crisis. However, existing research has primarily examined these themes in isolation. Few studies have attempted to combine ESG-focused firm selection with neural network modeling based on technical indicators. This research seeks to address that gap by applying an MLP neural network to forecast the stock prices of ESG-compliant companies, thereby bridging AI-driven forecasting with sustainable investment strategies.

III. RESEARCH OBJECTIVES

The primary aim of this study is to explore the effectiveness of neural networks in predicting the short-term stock prices of ESG-compliant companies by integrating technical indicators with artificial intelligence models. The specific objectives are as follows:

1. To analyze the stock price behavior of ESG companies using selected technical indicators, including Moving Average Convergence Divergence (MACD), Signal Line, and Histogram, in order to identify key patterns and predictive features.
2. To develop and train a Multilayer Perceptron (MLP) neural network model for forecasting short-term stock price movements of ESG firms based on historical market data.
3. To evaluate the predictive performance of the neural network model by comparing predicted stock prices with actual values, using error metrics and graphical validation techniques such as scatter plots

IV. RESEARCH METHODOLOGY

This study employs a quantitative, analytical research design to investigate the predictive accuracy of artificial neural networks in forecasting short-term stock prices of ESG-compliant companies. The methodology integrates secondary data collection, technical indicator computation, model construction using a Multilayer Perceptron (MLP), and validation through error metrics and graphical techniques.

1. Data Source and Sample Selection

This study employs a quantitative, analytical research design to investigate the predictive accuracy of artificial neural networks in forecasting short-term stock prices of ESG-compliant companies. The methodology integrates secondary data collection, technical indicator computation, model construction using a Multilayer Perceptron (MLP), and validation through error metrics and graphical techniques

2. Study Period

The time horizon spans from June 2024 to June 2025, covering one year of daily trading data. This period was selected to provide sufficient observations for training and testing the neural network while capturing both short-term fluctuations and sector-wide variations

3. Technical Indicators

Stock price behavior was analyzed using a combination of price-based, momentum-based, and trend-based indicators.

The following variables were computed and used as input features:

•Price Variables: Open, High, Low, and Close values.

•Volume Variable: Daily traded volume.

•Trend Indicators: Simple Moving Average (MA), Exponential Moving Averages (EMA-12 and EMA-26).

•Momentum Indicators: Moving Average Convergence Divergence (MACD), Signal Line, and Histogram.

These indicators were selected due to their widespread use in technical analysis and proven ability to capture underlying market dynamics. Specifically, MACD and Signal Line are powerful tools for momentum prediction, while EMA provides smoothed trend insights, making them well-suited for machine learning applications

4. Data Preprocessing

All data was preprocessed using Microsoft Excel. Missing values were handled using interpolation, and data was normalized to ensure consistent scaling across variables. This step was critical to improve the convergence of the neural network model and prevent bias towards variables with larger magnitudes (e.g., stock price vs. volume).

5. Neural Network Model development

A Multilayer Perceptron (MLP) neural network was selected due to its ability to approximate complex, non-linear functions. The network architecture consisted of:

- Input Layer: 12 neurons, corresponding to the technical indicators.
- Hidden Layer: One hidden layer with a nonlinear activation function, optimized for accuracy.
- Output Layer: A single neuron representing the predicted next-day stock price.

The network was trained using backpropagation, minimizing the error between predicted and actual prices. Data was divided into training and testing subsets to evaluate model generalizability. The Figure 1 compares a biological neuron with an artificial neuron, showing how inputs are combined and passed through an activation function.

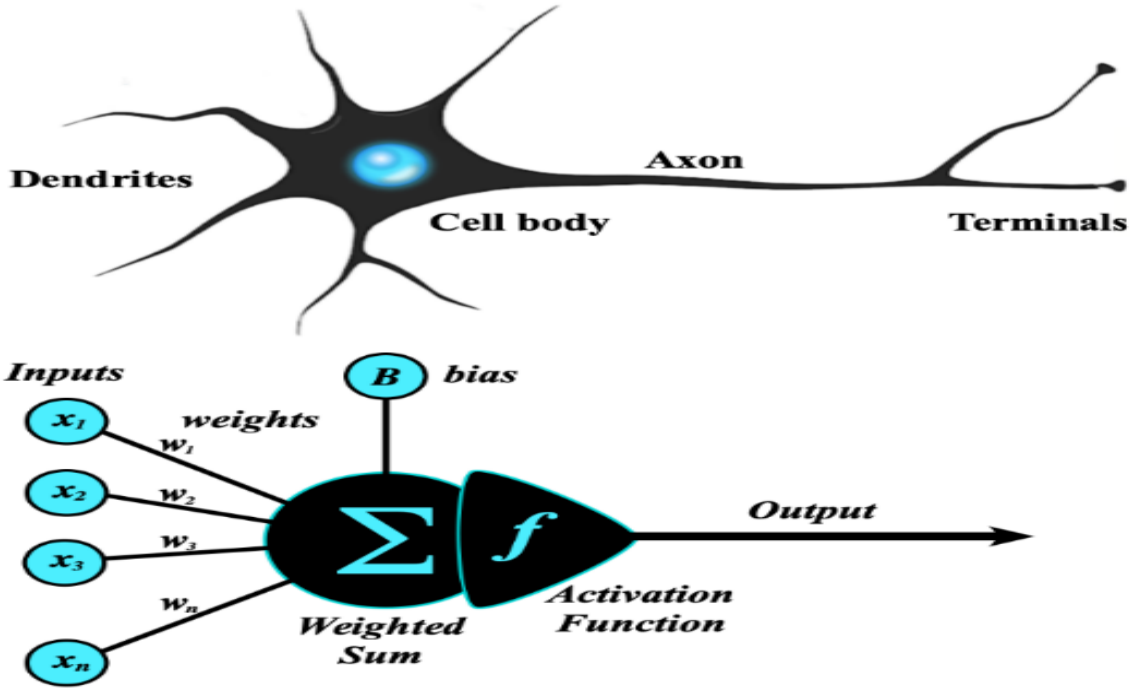

Fig.1 Neural Network

6. Model Validation and Performance Metrics

The model's predictive performance was evaluated using both graphical validation and statistical error measures. Scatter plots comparing predicted versus actual prices were generated to visually assess prediction accuracy and detect linear relationships. The Sum of Squared Errors (SSE) served as the primary performance metric, supported by error percentage calculations across companies. For most firms, prediction errors were found to be within ±1 of actual values, reflecting high accuracy and reliability.

This methodological framework was chosen for three reasons. First, ESG-based company selection enhances data stability and aligns with sustainable finance principles. Second, the inclusion of technical indicators ensures that both price behavior and market momentum are captured in the model. Third, the use of MLP networks enables accurate prediction of non-linear financial time series, outperforming traditional statistical models.

V. RESULTS AND DISCUSSION

The neural network model delivered strong prediction accuracy across all sectors included in the study. For most companies, the average error percentage remained below 1%, which highlights the effectiveness of the Multilayer Perceptron (MLP) in capturing short-term price fluctuations. For example, Adani Enterprises Ltd. recorded an error margin of 0.99%, and similar accuracy levels were observed in the IT, Healthcare, and FMCG sectors. This consistency across industries indicates that the model is robust and not limited to sector-specific behavior.

The analysis of input variable significance revealed that the closing price was the most influential predictor of stock price movement. Momentum indicators such as MACD and Signal Line followed as strong contributors, confirming their relevance in capturing price trends and reversals. These results emphasize that a combination of price-based and momentum-based indicators enhances the predictive capability of neural network models.

Graphical validation through scatter plots further confirmed the model's robustness. The predicted values aligned closely with the actual prices, forming a strong linear relationship. The limited spread of errors suggests that the model generalized well, producing stable and accurate forecasts without significant overfitting.

Another noteworthy outcome was that the use of ESG-compliant companies reduced noise in the dataset. These firms, due to their sustainable and ethical business practices, exhibited more stable trading patterns compared to broader market samples. As a result, the model achieved higher prediction reliability, reinforcing the practical advantage of integrating ESG-based company selection with artificial intelligence techniques.

Overall, the results demonstrate that the combination of technical indicators and neural networks provides a reliable framework for short-term stock price prediction. The findings also indicate that ESG-oriented companies offer a more predictable base for forecasting, making the approach highly relevant for sustainable investment strategies.

The Table 1 displays the average prediction error percentages for 16 Sectors (100 ESG-focused companies), showing a mix of positive and negative errors. Most companies exhibit minimal error rates, generally within ±1%, indicating a high degree of accuracy in the neural network-based stock price prediction model. Notably, the majority of companies have error rates close to zero, reinforcing the model's reliability across different sectors. Very few companies show slightly higher deviations, but these are still within acceptable limits, suggesting that the model performs well and can be effectively used for short-term forecasting in ESG-compliant firms.

Table 1 Sectors and its Average Percentage

S.No	Sectors	Average Percentage
1	Automobile and Auto Components	0.23 %
2	Capital Goods	0.45 %
3	Chemicals	-0.18 %
4	Construction Materials	0.26 %
5	Consumer Durables	-0.18 %
6	Consumer Services	-0.45 %
7	Fast Moving Consumer Goods	-0.14 %
8	Financial Services	0.35 %
9	Healthcare	-0.51 %
10	Information Technology	0.44 %
11	Metals & Mining	0.32 %
12	Oil Gas & Consumable Fuels	0.44 %
13	Power	0.50 %
14	Realty	0.84 %
15	Services	-0.68 %
16	Telecommunication	0.83 %

VI. CONCLUSION AND FUTURE SCOPE

This study demonstrates that neural networks, particularly the Multilayer Perceptron (MLP), can effectively predict short-term stock prices of ESG-compliant companies. By integrating widely used technical indicators such as closing price, MACD, and Signal Line into the modeling framework, the approach achieved high prediction accuracy across multiple sectors. The results confirmed that the closing price is the most influential predictor, while momentum indicators play a critical supporting role in forecasting. The contributions of this research are threefold. First, it combines ESG-based company selection with neural network forecasting, thereby bridging sustainable investing and artificial intelligence. Second, it validates the significance of technical indicators, particularly closing prices and momentum signals, in building accurate predictive models. Third, it provides practical value for investors and traders by showing that ESG-compliant

firms present more stable and predictable price patterns, making them suitable for responsible investment strategies.

Looking ahead, the study can be further enhanced in several ways. Incorporating ESG scores directly into the model would allow for a more comprehensive integration of sustainability metrics. Additionally, the use of sentiment analysis from financial news and social media could provide valuable insights into market psychology, complementing technical indicators. Finally, extending the model to include macroeconomic variables such as interest rates, inflation, and policy announcements could improve its robustness in capturing broader market dynamics. Overall, the research highlights the potential of combining ESG-focused company selection with AI-driven modeling, offering a valuable tool for advancing sustainable finance.

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